

Foot and Mouth Disease (FMD)

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Importance

Foot-and-mouth disease (FMD) is highly contagious and can rapidly spread through a region if control and eradication practices are not put into place as soon as the disease is identified. Weight loss, poor growth, permanent hoof damage, and chronic mastitis are just some of the sequelae of infection. International trade embargoes that can result in significant economic losses.

Etiology

The foot-and-mouth disease virus (FMDV) is in the family Picornaviridae, genus *Aphthovirus*. There are 7 immunologically distinct serotypes and over 60 subtypes. New subtypes occasionally develop spontaneously. The FMDV is inactivated at a pH below 6.5 or above 11. The virus is protected in milk and milk products when regular pasteurization temperatures are used. However, it is inactivated when ultra high pasteurization procedures are used, and stability increases at lower temperatures. It can survive in frozen bone marrow or lymph glands. In organic material such as serum, the virus can survive drying. It can remain active for days to weeks on organic rich materials under moist and cool temperatures. It is inactivated on dry surfaces and by UV radiation (sun light)

Species affected

FMDV primarily affects cloven-hoofed domestic and wild animals, including cattle, pigs, sheep, goats, and water buffalo. Other susceptible species include hedgehogs, armadillos, nutrias, elephants, capybaras, rats, and mice.

Geographic distribution

Foot-and-mouth disease was found worldwide after World War II. The last U.S. outbreak was in 1929. Endemic areas are Asia, Africa, the Middle East, and parts of South America. Epidemics have recently occurred in Taiwan, South Korea, Japan, Mongolia, Britain, France, and The Netherlands. North and Central America, Australia, and New Zealand have been free for many years.

Transmission

Transmission primarily occurs by respiratory aerosols and direct or indirect contact with infected animals. Aerosol transmission requires proper temperature and humidity. Aerosol spread has occurred from bulk milk trucks. FMDV can survive for 24 hours in the human respiratory tract. Feeding of infected animal products such as meat, milk, bones, glands and cheese can also spread the disease. Contact with contaminated objects such as boots, hands or clothing can be a source of infection. Another source of infection is artificial insemination and contaminated biologicals and hormone preparations.

Sheep and goats are considered maintenance hosts. They can have very mild signs; therefore, diagnosis may be delayed allowing time for aerosol and contact spread and

environmental contamination. In pigs, FMDV spreads rapidly due to thousands of times higher virus particle concentration in aerosols as compared with other species. They are considered amplifying hosts. Cattle are considered 'indicators' of this disease because they generally are the first species to show signs of infection. Their lesions are more severe and progress more rapidly.

Ruminants can carry the virus for long periods in their pharyngeal tissue. Recovered or vaccinated cattle exposed to diseased animals can be healthy carriers for 6-24 months. Sheep can be carriers for 4-6 months. Pigs are not carriers of FMDV. Some strains of the virus can affect one species more than others.

Incubation period

Animals in contact with clinically infected animals will generally develop signs of disease in 3-5 days. The virus can enter through damaged oral epithelium or the tonsils in pigs fed contaminated garbage. In this case signs can be seen in 1-3 days. Experimental exposure can elicit signs in 12-48 hours. Peak time of shedding of the virus and transmission usually occurs when vesicles rupture.

Clinical signs

Foot-and-mouth disease is characterized by fever and vesicles (blisters), which progress to erosions in the mouth, nares, muzzle, feet, or teats. These signs can lead to depression, anorexia, excessive salivation, serous nasal discharge, decreased milk production, lameness, and reluctance to move. Abortion may occur in pregnant animals due to high fever (FMD virus does not cross the placenta). Death in young animals is due to severe myocardial necrosis. In cattle, oral lesions are common with vesicles on the tongue, dental pad, gums, soft palate, nostrils, or muzzle. Hoof lesions are in the area of the coronary band and interdigital space. In pigs the hoof lesions are usually severe with vesicles on the coronary band, heel, and interdigital space. Vesicles can be seen on the snout. Oral lesions are not as common as in cattle and are usually less severe. Drooling in pigs is rare. Sheep and goats show very mild, if any, signs of fever, oral lesions, and lameness. Animals generally recover in about 2 weeks with very low mortality in adult animals. Secondary infections may lead to a longer recovery time.

Post mortem lesions

The diagnostic lesions of foot-and-mouth disease are single or multiple vesicles from 2mm to 10cm in size. Lesions may be seen in any stage of development from a small white area to a fluid filled blister, sometimes joining with adjacent lesions. The vesicles rupture, leaving a red eroded area, which is then covered with a gray fibrinous coating. This coating becomes yellow, brown, or green then is replaced by new epithelium with a line of demarcation that gradually fades. Occasionally the fluid may escape through the epidermis instead of forming a vesicle. These "dry" lesions appear necrotic instead of vesicular. "Dry" lesions are more common in the pig oral cavity. Lesions at the coronary band progress similarly: the skin and hoof separate and, as healing occurs, a line showing evidence of coronitis appears on the hoof. Pigs may actually lose the hoof in severe cases. "Tiger heart" lesions may also be seen; these lesions are characterized by a gray or

yellow streaking in the myocardium caused by degeneration and necrosis. Vesicular lesions may also be seen on the rumen pillars.

Morbidity and Mortality

Morbidity can be 100% in a susceptible population. Mortality is generally less than 1%. In younger animals or with more severe strains mortality can increase.

Diagnosis

Clinical

Clinical signs of concurrent salivation and lameness with vesicular lesions should make foot-and-mouth disease a differential consideration. Fever is often the first sign, so these animals should be carefully examined for early lesions on the mouth and hooves. The mouth of any lame animal, and the feet of animals with oral lesions or drooling, should also be checked. Tranquilization may be necessary for a thorough examination as vesicles may be difficult to see. Laboratory testing is an absolute requirement to confirm FMDV infection as all vesicular diseases have almost identical clinical signs.

Differential diagnosis

The clinical signs of foot-and-mouth disease can be similar to vesicular stomatitis, swine vesicular disease, vesicular exanthema of swine, foot rot, and chemical and thermal burns. In cattle, oral lesions seen later in the progression of FMD can resemble rinderpest, infectious bovine rhinopneumonitis, bovine virus diarrhea, malignant catarrhal fever, and bluetongue. In sheep, these later lesions can resemble bluetongue, contagious ecthyma, and lip and leg ulceration.

Laboratory tests

FMDV can be identified using enzyme-linked immunosorbent assay (ELISA), complement fixation, and virus isolation. Virus isolation is done by inoculation of primary bovine thyroid cells and primary pig, calf and lamb kidney cells, inoculation of BHK-21 and IB-RS-2 cell lines, or inoculation of mice. ELISA and virus neutralization tests can be used to detect antibodies in serum. Virus isolation and identification must be performed on the initial case. Subsequently, antigen or nucleic acid detection can be used to diagnose additional cases in an outbreak.

Samples to collect

Before collecting or sending any samples from vesicular disease suspects, the proper authorities should be contacted. Samples should only be sent under secure conditions and to authorized laboratories to prevent spread of the disease. Since vesicular diseases can not be distinguished clinically, and some are zoonotic, samples should be collected and handled with all appropriate precautions. Samples include vesicular fluid, the epithelium covering vesicles, esophageal-pharyngeal fluid, unclotted whole blood collected from febrile animals, and fecal and serum samples from infected and non-infected animals.

Recommended actions if foot-and-mouth disease is suspected

Notification of authorities

A quick response is vitally important in containing an outbreak of foot-and-mouth disease. State and federal veterinarians should be immediately informed of any suspected vesicular disease. Federal: Area Veterinarians in Charge (AVICS)

http://www.aphis.usda.gov/vs/area_offices.htm

State vets: <http://www.aphis.usda.gov/vs/sregs/official.html>

Quarantine and Disinfection

Suspected animals should be quarantined immediately and the premises should be disinfected. Sodium hydroxide (2%), sodium carbonate (4%), and citric acid (0.2%) are effective disinfectants. FMDV is resistant to iodophores, quaternary ammonium compounds, hypochlorite, and phenol in the presence of organic matter

Vaccination

There are seven serotypes of FMD with more than 60 subtypes. There is no universal vaccine against the disease. FMD vaccines used in an outbreak must closely match the type and perhaps the subtype causing the disease outbreak. The U.S., Canada, and Mexico maintain the North American FMD Vaccine Bank which contains vaccine strains for the most prevalent circulating serotypes in the world. The decision to use vaccination as an aid in controlling an outbreak of FMD in the U.S., Canada, or Mexico would be made by the Chief Veterinary Officer in each country. The decision to use vaccination in control and eradication efforts is complex and depends upon scientific, economic, political, and societal factors specific to the outbreak situation.

Public health

FMDV infections in humans are rare, with just over 40 cases diagnosed since 1921. Vesicular lesions can be seen, but the signs are generally mild. Foot-and-mouth disease is not considered to be a public health problem.

For More Information

World Organization for Animal Health (OIE)

<http://www.oie.int>

OIE Manual of Standards

http://www.oie.int/eng/normes/mmanual/a_summry.htm

OIE International Animal Health Code

http://www.oie.int/eng/normes/mcode/A_summry.htm

USAHA Foreign Animal Diseases book

http://www.vet.uga.edu/vpp/gray_book/FAD/

References

House, J. and C.A. Mebus. "Foot-and-mouth disease." In *Foreign Animal Diseases*. Richmond, VA: United States Animal Health Association, 1998, pp. 213-224.

“Foot and mouth disease.” In *Manual of Standards for Diagnostic Tests and Vaccines*. Paris: World Organization for Animal Health, 2000, pp. 77-92.

Foot and Mouth Disease. Disease Lists and Cards. *Office International des Epizooties*. <<http://www.oie.int>>.